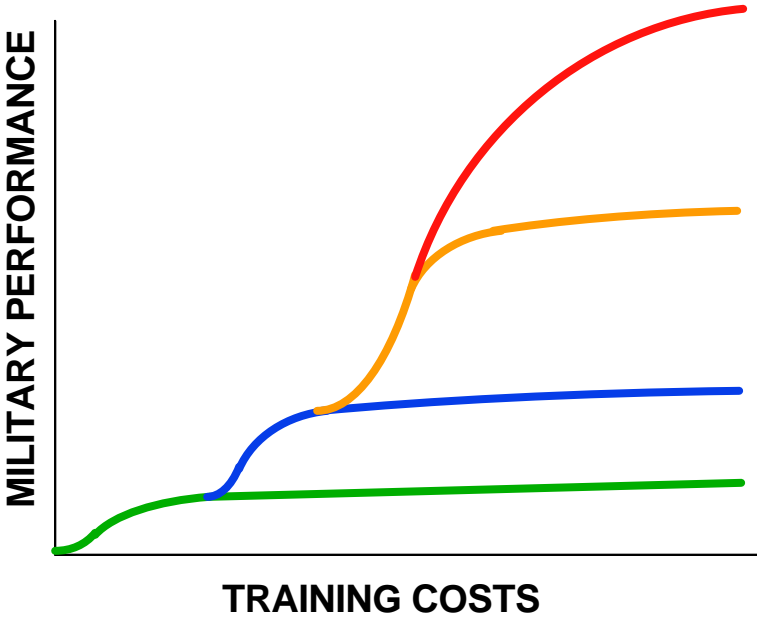


Defense Science Board Task Force

Training Superiority & Training Surprise *Final Report*

Dr. Ralph Chatham
Dr. Joe Braddock
Co-Chairmen



In late 1998 the Undersecretary of Defense (Personnel & Readiness), the Director, Defense Research and Engineering, and the Joint Chiefs of Staff requested the Defense Science Board to create a task force on training and education. Drs. Joe Braddock and Ralph Chatham were appointed Co-Chairmen. The task force met periodically throughout 1999 and early 2000. This document is the report of our deliberations.

Much of what follows is anecdotal and less quantitative than we would have preferred. Unlike the other Title 10 Service responsibilities (man & equip), training performance and resulting military proficiency are not well measured. Training is therefore easier to ignore than things that can be counted like people and planes. Thus, many of the training issues we raise are structural rather than technological; we found no one in the Pentagon with sufficient authority who is graded on force-wide training performance.

As we proceeded, our emphasis shifted away from education to highlight training superiority and training surprise. We were struck not only by the achievement of the Services where they apply engagement simulation in combat training centers (CTCs) but by the failure of other nations to do this. This is, in part, due to a lack of resources, but there is more to it.

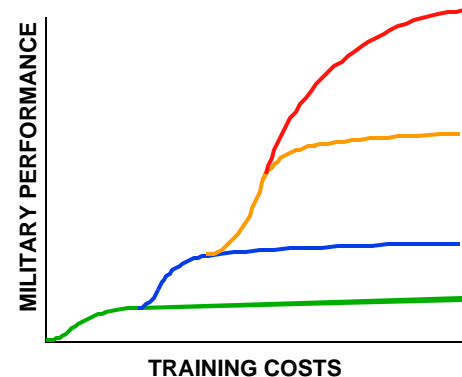
This training revolution (CTC use) appears to be a uniquely American institution and not well coupled to more hierarchical cultures. It has had as profound an impact on warfare proficiency as advocates hope that the revolution in military affairs (RMA) will achieve in the future. The training revolution, however, is real and here now. Unfortunately, unless we provide it more support than we have in the last few years, it may not be here tomorrow.

A second training revolution is brewing. Without it the RMA can not be sustained. Thoroughly trained warriors are required to support concepts of massing fires, not forces, with widely-spaced units flawlessly connected to each other & to their command structure. Future training must be delivered to the individual, to units and to joint forces, when it is needed, not in the schoolhouse after which there is time for proficiency to decay.

Defense Science Board Task Force

Training Superiority & Training Surprise *Final Report*

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nsu0071 - db training v 01152001 page 1

- ◆ *This report can be read on three levels: viewgraph, caption (of which this is one) and amplifying text. The sketch above suggests the relation between performance of complex tasks and a hierarchy of part-task learning curves that make for effective unit and individual training. See page 4 for more details.*

Training must be applied over and over again as the composition of the units and joint forces change and as skills erode over time. Training must also become an integral part of the acquisition of hardware or we will fail to achieve the performance in our weapons systems that our other superiority (technology) strives to deliver.

Fortunately, technology is emerging that will support this and may save money in the process. Unfortunately, there is no training laboratory, nor development establishment nor manager with

sufficient authority who can foster the second training revolution.

Training Surprise: In the last decade we surprised not only others but ourselves with our warfare proficiency. There is evidence that the culture of our first training revolution is itself trainable. A potential enemy might also be able to capitalize on the new training revolution. In 1994 Croatia surprised the Serbs with a military proficiency built up in one year. Others could surprise us. Training superiority is ours to lose and for others to gain.

Summary

- ◆ Our uniquely American *Training Superiority* is eroding
- ◆ JV2010/2020 future will require more training, not less
- ◆ Training failure will negate hardware promise
- ◆ A second revolution in training is needed and is possible
 - *This new revolution should be able to pay for itself but:*
 - ✧ The incentive structure in the DoD won't foster the revolution without help
 - ◆ A central cause is that *training performance is not measured*
- ◆ Training should take its Title 10 seat with “Man & Equip”
 - *Restore & expand upon crown jewels of current training revolution (CTCs)*
 - *Establish and test co-equal training subsystem in each acquisition program*
 - *Raise OSD/Acquisition training conscience:*
 - ✧ Services & CINCs deliver annual training report card to Deputy Sec. Defense
 - ✧ Designate ASD/DUSD to be held accountable for training performance
 - *Foster the second training revolution by establishing:*
 - ✧ ACTD-like pilot programs in computerized self-paced and unit-based training
 - ✧ An advanced training research program element
 - ✧ DARPA office to develop high payoff training/human performance technology
- ◆ DoD & Intel Community act to detect & avoid Training Surprise

The People and the Places

◆Co-Chairmen

Dr. Joe Braddock
Dr. Ralph Chatham

◆Task force members &
government advisors :

Dr. John Christie
Dr. Paul Chatelier
Dr. Dexter Fletcher
LTG Bill Hilsman, USA (ret)
Dr. Sung Lee
RADM Fred Lewis USN (ret)
Mr. Joe Markowitz
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Dr. Harry O’Neil
Dr. Gershon Weltman
VADM J.D. Williams, USN (ret)
Dr. Paris Genalis
RADM Jerome Smith, USN (ret)
CAPT Wayne Thornton, USN(ret)
Ms. Sandra Wetzel-Smith

◆Executive Secretary

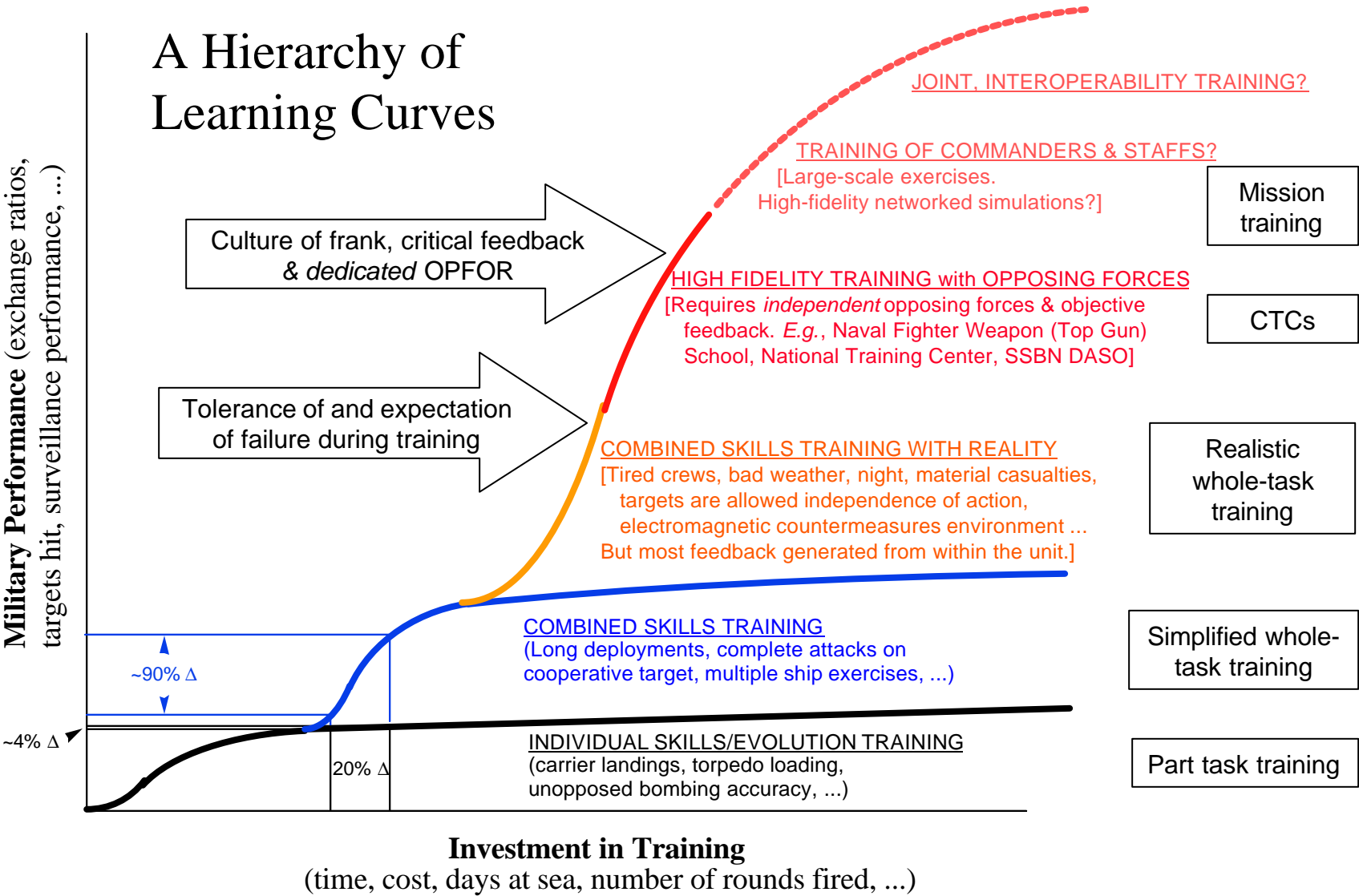
Mike Parmentier
& Dan Gardner

Briefers, Contributing Organizations, Site Visits

ODUSD(R)R&T,PP
Joint Staff (J-7) (JV2010)
USMC Combat Development Command
Defense Intelligence Agency
Joint Staff (J-7) (JPME)
USA Training Doctrine Command
AF Directorate of C² (XOC)
Dep. Dir. Naval Training (N-7B)
USA Training Directorate (DAMO-TR)
Dep.Chief NAVPERS (pers. & tra. Interfaces)
USMC Dep COS, Manpower&Reserve Affairs
USAF Dep COS for Pers, Edu. & Training
Joint Staff (J-7) (DOCNET demo)
A Dep. Chief NAVPERS (pers.& tra. resource)
USAF Edu. & Tra, Command (AETC)
OUSD for Acquisition, Technology, & Logistics
ODUSD for Program Integration
ODUSD(R) Readiness and Training
General Motors
HMT-303, FREST (maintenance monitoring)
DUSD Readiness
Defense Acquisition University (DAU)
USN Aegis Training & Readiness Center
Navy CVX Program Mgr. (PMS 378)
DD 21 Program Office, Manning, HSI, &
Training Manager (PMS 500)
Apache PMO, USA Aviation Training Cntr.
Dr. J. Bruer; James S. McDonnell Foundation
Nav. Air Warfare Ctr. Training Systems Div.
USAF Research Lab, Mesa, AZ.

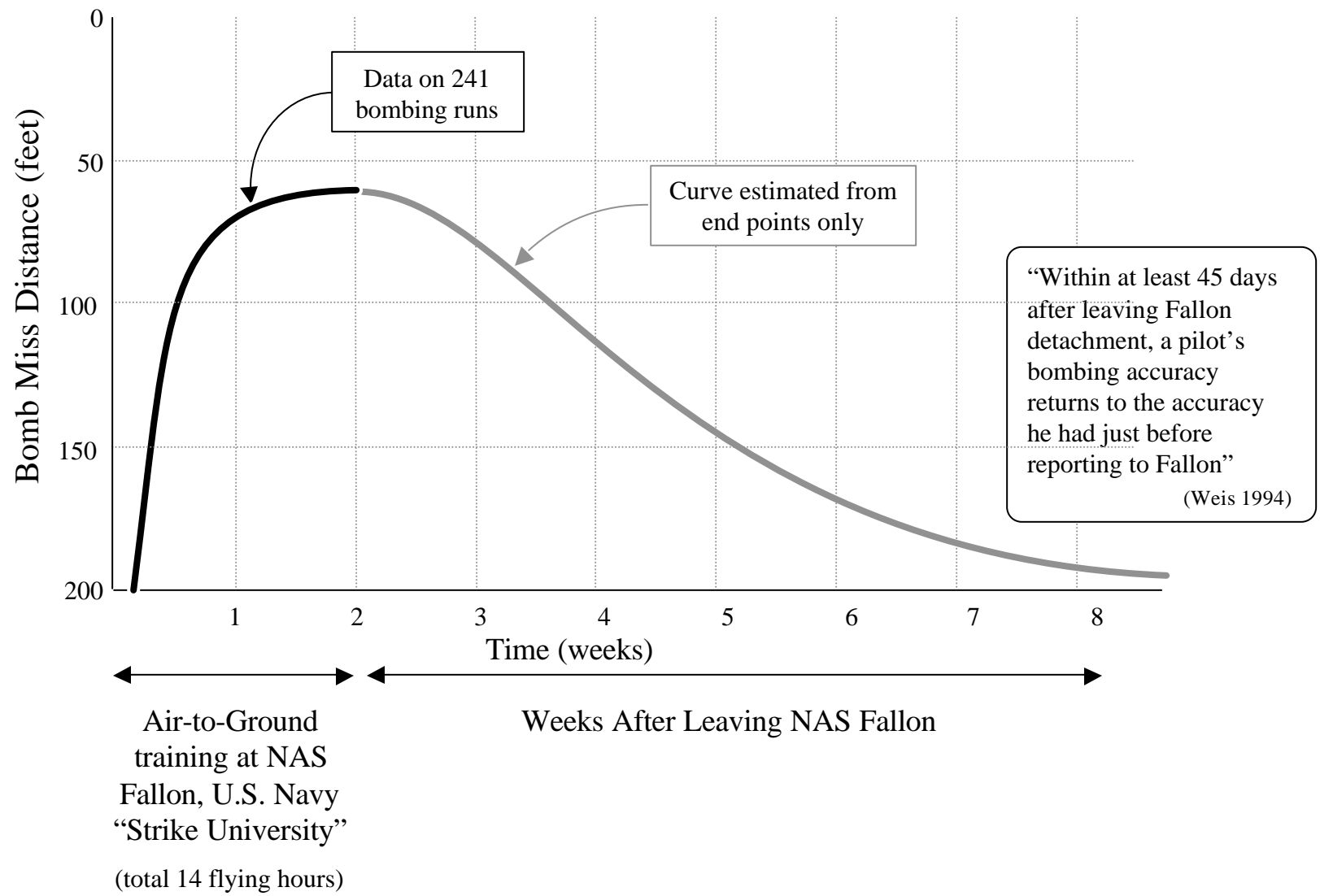
Dr. D. Towne; Behavioral Tech. Labs, USC
Dr. R. Sternberg; Yale University
Dr. A. Lesgold; University of Pittsburgh
Dr. A. Graesser; University of Memphis
Dr. R. Wisher; USA Research Institute
LTG Hilsman: USA Battle Cmd Sys.
USA 3 Corps, DCOS - Ft. Hood, TX
Digital Force Coordination Cell Dir., Ft. Hood
Technical Director & CCTT Dir., Ft. Hood
CTS Technical Director - Ft. Hood
Director, NSC DIO - Ft. Hood
CDR Navy Strike & Air Warfare Center
NSAWC - (multiple staff briefers) NAS Fallon
414th Combat Training Squadron, Nellis AFB
Commander 57th Wing Nellis AFB
Commandant, USAF Fighter Weps. School
D. Commandant, USAF Ground Ops School
Joint Forces Command (JFCOM),
Joint Warfighting Center (JWFC),
Joint Training, Analysis, & Sim. Center
(JTASC)
JFCOM (J-7)
ODUSD (S&T), Director, Biosystems
JWFC, Dir. For Interoperability
Nat’l Intel Officer Conventional Military Issues
DIA, CIA, and Service Intel centers
Director, OSD Readiness and Training
Space & Naval Warfare Center (IMAT brief)
Director, OSD (R&T) Adv. Dist. Learning
DoD Chancellor, Edu. & Prof. Development

Anatomy of Effective Training

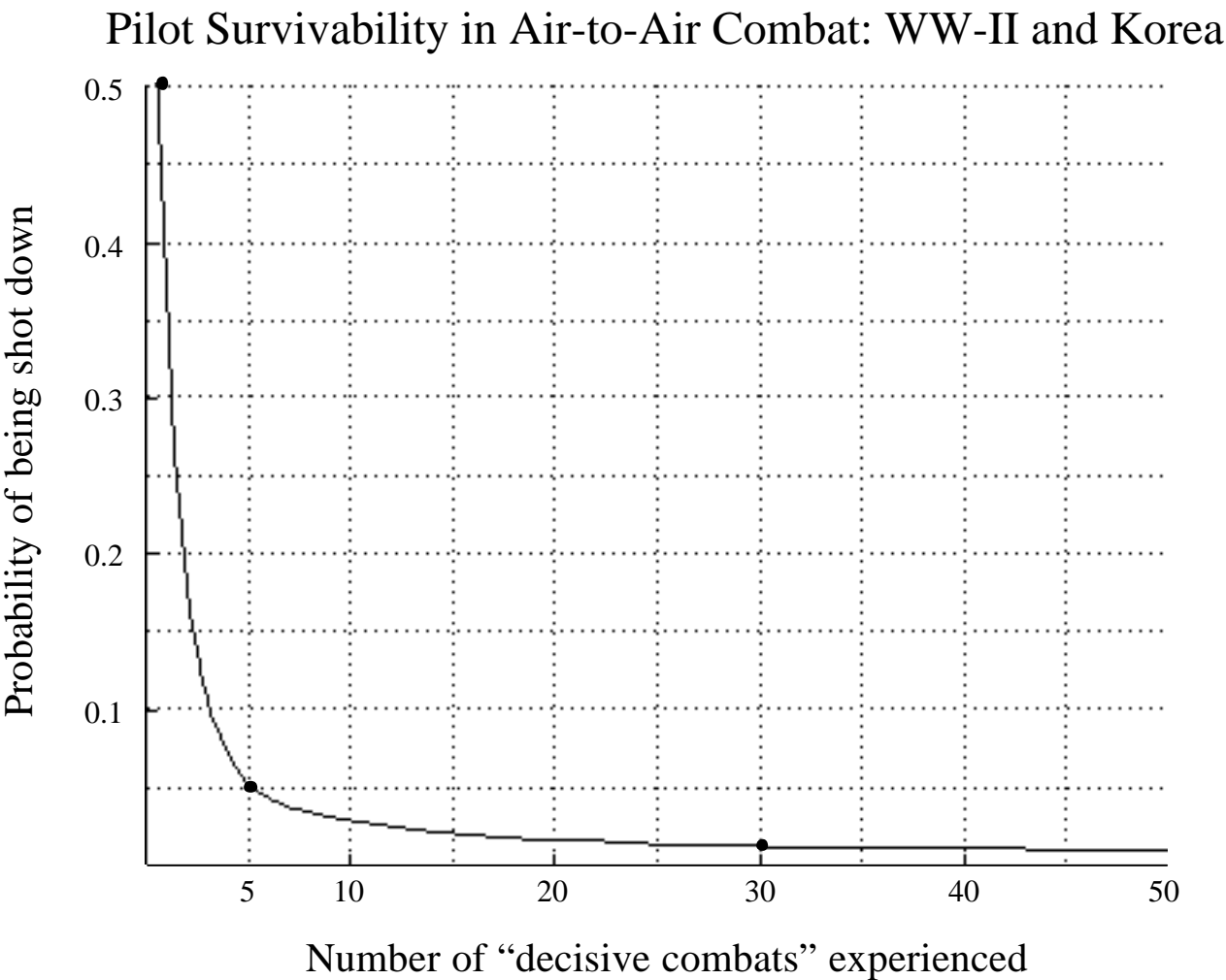


A Forgetting Curve

Bombing Accuracy of F/A-18 Pilots



The Evolution of a Combat Ace



Is this training or “survival of the fittest?”

Data from H.K. Weiss, *Achieving System Effectiveness*, AIAA, New York, 1966,
See also: P.F. Gorman, *The Military Value of Training*, IDA, Alexandria, VA 1990

Our Second Superiority

- ◆ The superb performance of our military in the 1990s was not just a result of technological superiority but equally of
TRAINING SUPERIORITY
- ◆ New combat training approach invented 30 years ago develops, without bloodshed, individuals & units into aces
 - ✧ Instrumented ranges at major Combat Training Centers (CTCs)
 - ✧ Highly competent Red/Opposing Force uses “enemy” equipment and tactics
 - *Uniquely coupled to American culture*
 - ✧ Objective, no-holds-barred feedback/replay
 - ◆ no longer does first person to blackboard win
 - ✧ Expectation of failure in the trained unit and its commanders
 - *Used by Army & most of the air forces (USAF, USN)*
- ◆ A second training revolution is brewing
 - *It will be needed for future warfare*
 - *But there are impediments to its implementation*

Effective Training Makes a Difference

◆Air-to-Air Combat Over Viet Nam

1970-73



◆National Training Center ~1987

Change in proficiency

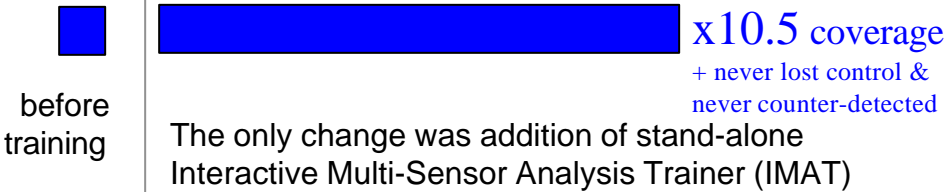


◆Submarine Tactical Sensor Employment 1999

Detect and track coverage

TWO DAYS

Performance of 8 boats in 5 day exercises



State of the Combat Training Centers

Proficiency consequences not quantified

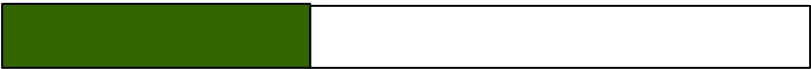
◆ Army

1998



Achieved during NTC deployments: 65-75%
25-35% of unit sits out exercise for lack of vehicle

Goal for NTC combat vehicle availability: 90%



40% vehicle commonality
60% of vehicles issued at NTC not common with those at units' home stations

◆ USAF CTC (Nellis AFB)

1989



4 active duty aggressor squadrons with 24 dissimilar aircraft each

◆ Navy Air CTC (NAS Fallon)

1994



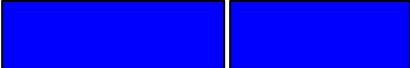
4 active duty adversary squadrons with 20+ dissimilar aircraft each

Dec 1999



8-10 dedicated
OPFOR F-16s.
All old and unreliable

Dec 1999



23 old dissimilar aircraft, reserve pilots, limited to 3G maneuvers
15 flyable F-18
5 flyable F-14

Both:
Limited live firings.
Incoming pilots have fewer flight hours.
Antiquated EW for OPFOR.
Limited maintenance and support budgets,
...

1999 Cost to upgrade NAS Fallon EW and provide 18 dissimilar OPFOR aircraft (F-16) ~ \$940M

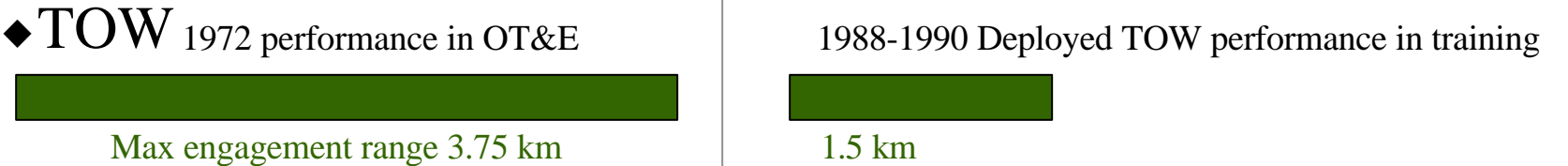
- ◆ Infrastructure is eroding & does not represent current threats
- ◆ No CTCs for non-air Navy, parts of USA & USAF, logistics & support forces & no CTC for joint/interoperability training

11

Risk That Hardware Performance Won't Be Realized

Inadequate training

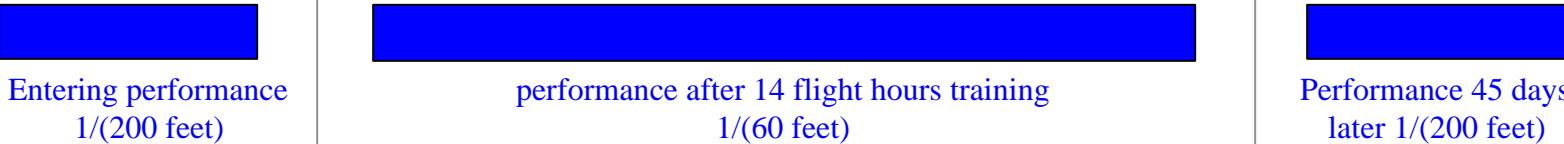
◆ Acquisition performance is usually predicated on perfect operators



◆ Submarine Acoustic Rapid COTS Insertion (ARCI) Program

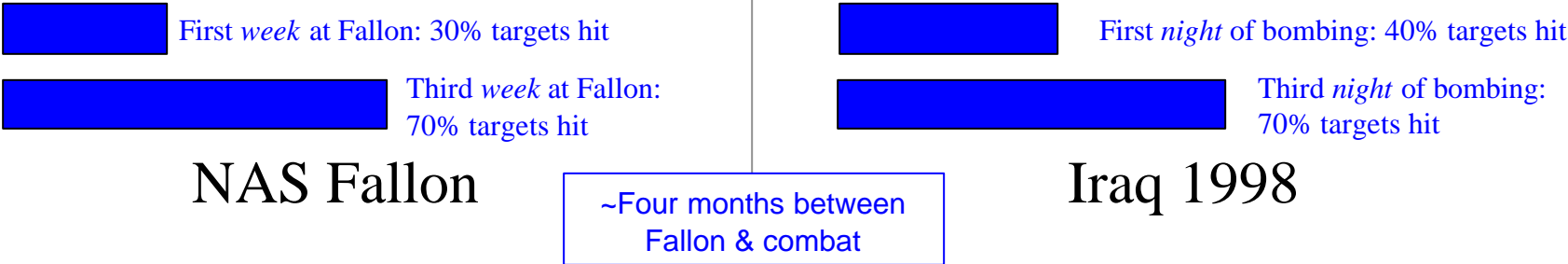


◆ Air-to-Ground Accuracy, USN Strike University ~1990-94



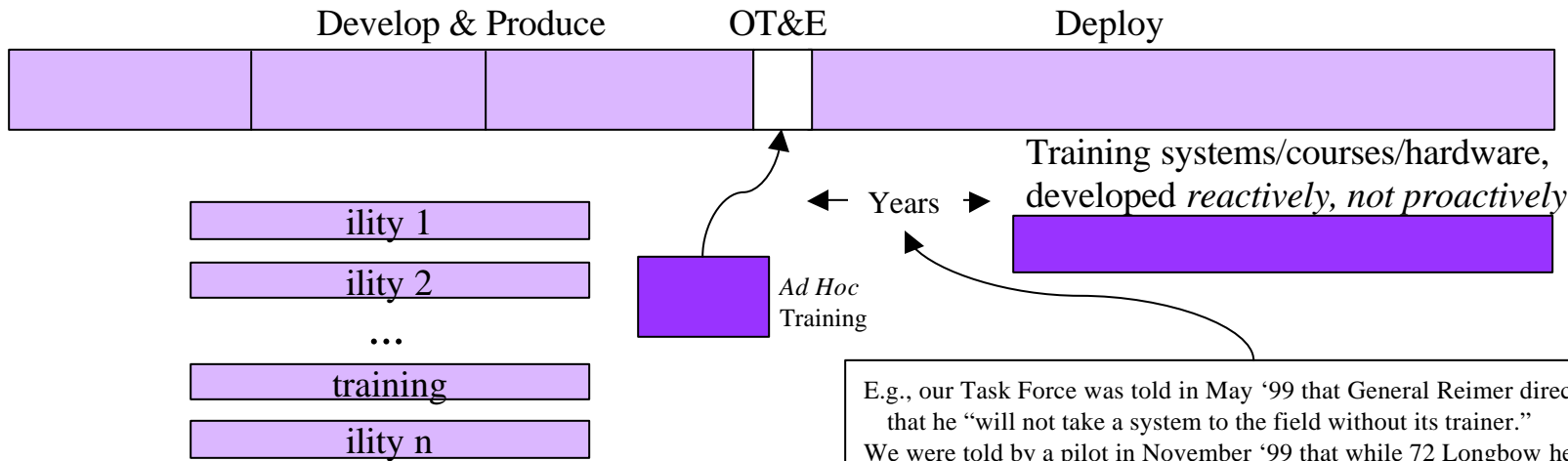
Skill Decay

◆ USN Carrier Air Wing Air-to-Ground Performance



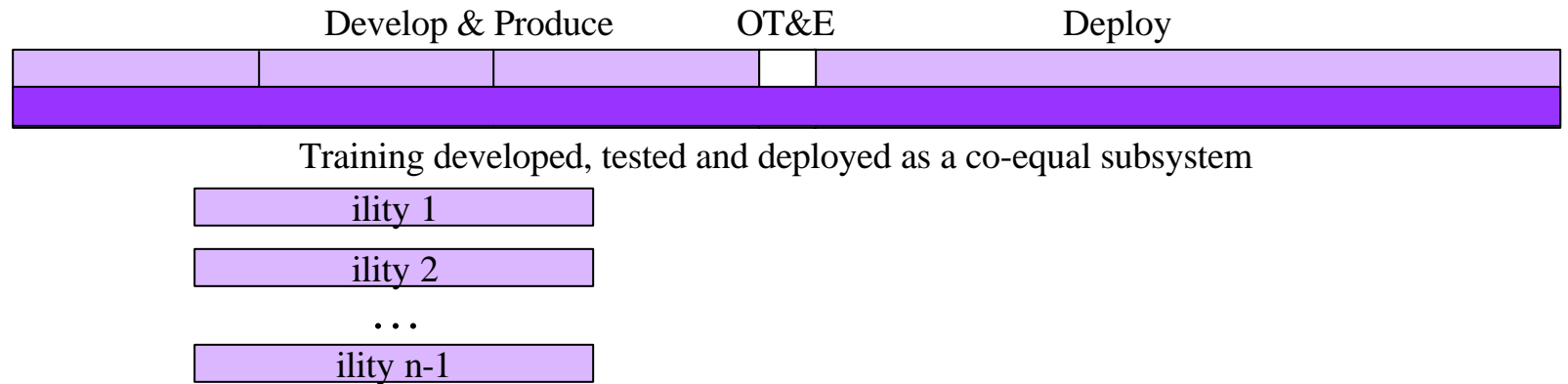
Required: A Formal Change to Acquisition System

◆ Acquisition Now

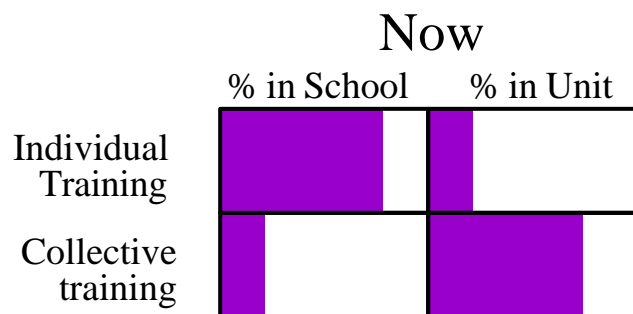


E.g., our Task Force was told in May '99 that General Reimer directed that he "will not take a system to the field without its trainer." We were told by a pilot in November '99 that while 72 Longbow helos had become operational over the past two years the trainer had not yet been fielded and would not be until July 2000. The date has now been extended to December 2000.

◆ Acquisition Future

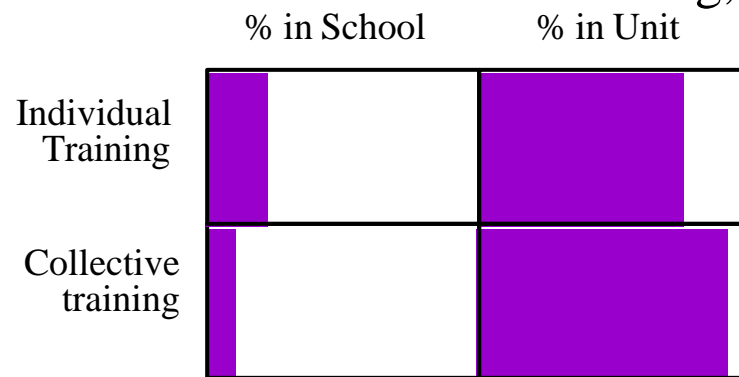


A New Training Revolution Is Needed



Mass Forces

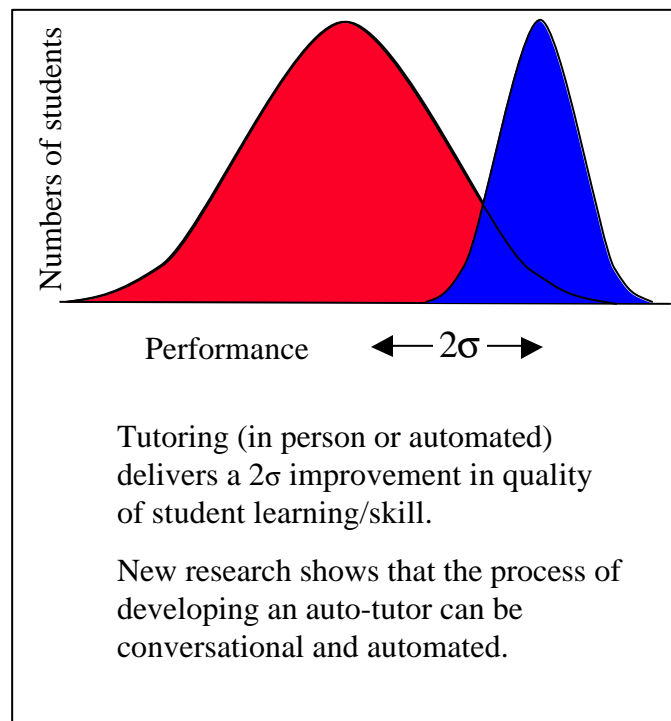
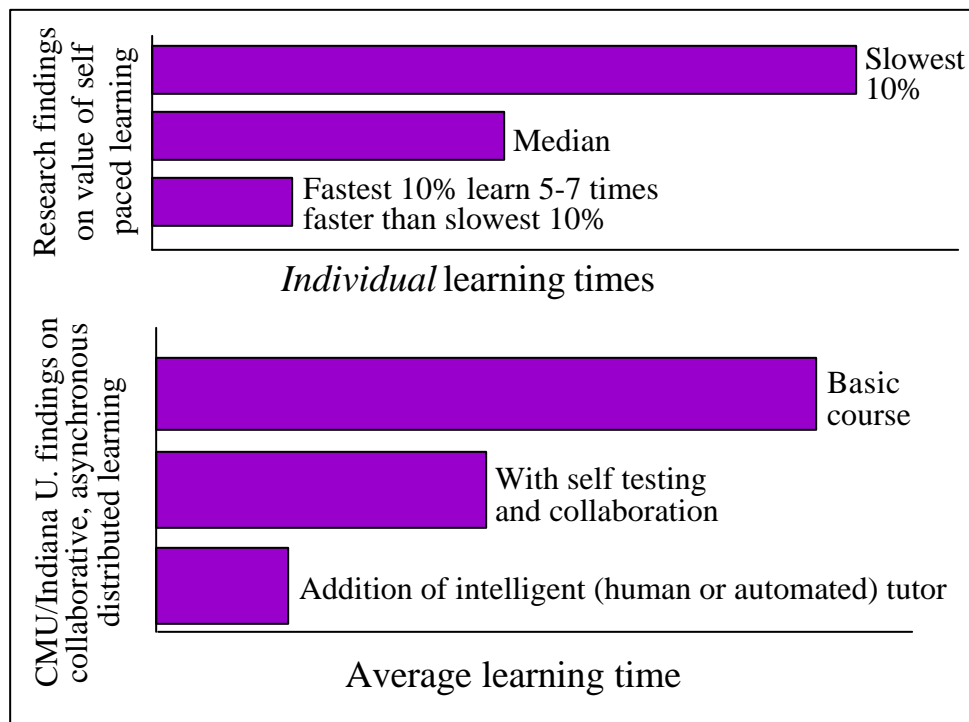
Future: *more* total & more unit training, not less



Mass Effects, Disperse Forces

- ◆ Even if warfare doesn't change, budget pressure will require new training approaches
- ◆ Existing Service CTCs are not sufficient to train for future (JV2010/2020) warfare
 - *CTCs do not/will not cover: joint warfare, deployment, ground force use of over-the-horizon weapons, ships/submarines, interoperability, new threats, USA's Future Combat System, ...*
- ◆ Future weapons technology also appears to require more training, not less
 - *E.g., the Digital Division must train for both old and new equipment*
 - *Sophisticated maintenance & operational skills can't be retained after leaving schoolhouse*
- ◆ Emerging manpower limitations will:
 - *Generate further personnel turbulence increasing the need for more training of more people*
 - *Demand shorter training pipelines*
 - *Decrease manpower that can be allotted to schoolhouses (instructors, support personnel)*

A New Training Revolution Is Possible




- ◆ We stand on the verge of a potential training revolution in:
 - *Advanced computer learning, just-in-time/just-right training devices, electronic classrooms, distributed learning environments, advanced embedded training, virtual environments, distributed learning, training administration and resource management (preventing entropy from growing in courseware), automated courseware development, automated auto-tutor development*
- ◆ The new training can be cheaper, faster and there when needed (avoiding skill decay)
- ◆ New efficiencies (e.g., in training tailored to the individual) will free-up resources for efforts critical to retaining and expanding our training superiority

A Sample of the New Revolution: Auto-Tutor

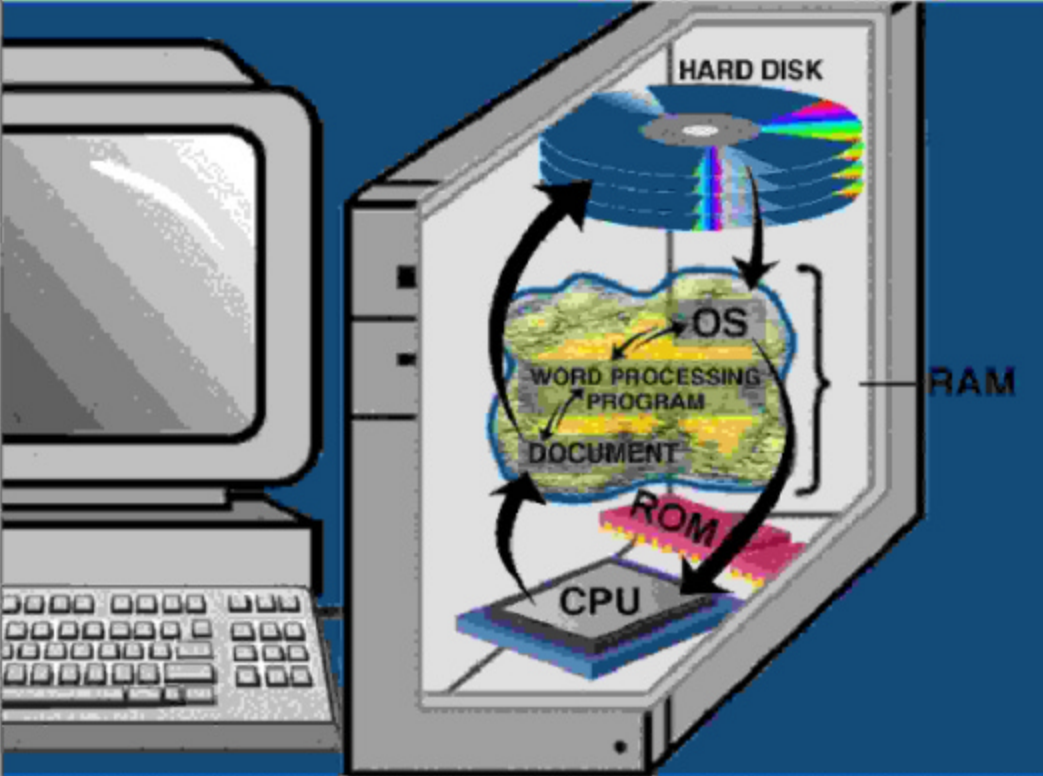
- ◆ Human tutors evoke 2σ performance increase
- ◆ It appears that this kind of teaching can be automated
 - *U. of Memphis built Auto-Tutor to teach basic computer literacy*
 - ✧ Personal computer based system
 - ✧ Line-drawing of human face asks questions (sight and sound)
 - ✧ Student responds on keyboard
 - ✧ Auto-tutor's response to student comes as much from facial expression as spoken/written words
- ◆ Developing new courseware can also be automated
 - *Converting auto-tutor to new subject area requires only:*
 - ✧ Scanning in background papers for latent semantic analysis
 - ◆ Uses technology developed for automated essay grading
 - ✧ Set of questions & acceptable answers conversationally elicited from expert
 - ✧ The rest can be automated
- ◆ JFCOM exploring concept for joint task force officer training

Auto-Tutor (2)

AutoTutor Student / Tutor Dialog



How does the operating system interact with the word processing program when you create a document?



The operating system loads the document for the application.

Incidentally, if this face does not inspire confidence, a different one can be chosen to suit your cultural preferences.

New Criteria for Predicting Individual Success

- ◆ New research suggests that there are *three* kinds of intelligence
 - *Analytic: ability to think abstractly, verbal abilities (what we currently call intelligence)*
 - *Practical: ability to adapt to a changing environment (problem solving in specific situations)*
 - *Creative: dealing with unusual situations*
- ◆ Current (analytic) measures have only .30 correlation with success
- ◆ The others have a similar $\sim .30$ correlation but are independent of each other
- ◆ All three are **well-defined** and have **repeatable measures**
- ◆ Use of all three measures (Sternberg's Successful Intelligence) can:
 - *Permit better coupling of training to the individual*
 - *Improve the accuracy of recruiting assessments*
 - ✧ *Wider field of acceptable applicants; fewer dropouts*

Payoff from the Second Training Revolution

- ◆ Army Science Board found (1997)
 - *For 525 Army schoolhouse courses and 30% reduction of instructional time from self paced learning alone:*
 - ✧ Potential >10,000 man-year savings and \$114M per diem costs per year
- | | |
|--|--|
| <p>Now: schoolhouse fixed-time training costs</p> <p>Current costs</p> <p>\$4.4B/yr DoD-wide specialized training costs [those that change with student load (1996) <i>not</i> including student pay]</p> | <p>A possible future: Self-paced training: 30-80% shorter training time in the schoolhouse and consequently lower costs</p> <p>Possible future costs</p> <p>Potential \$1B/yr DoD-wide <i>schoolhouse</i> savings from self-paced individual residential training alone.</p> |
|--|--|
- ◆ A more extreme future: People stay in the units
 - *Over \$3B direct savings DoD-wide, if personnel system can reallocate the savings*
 - *Personnel turbulence reduced by 40%*
 - *Learn material in 1/2 to 1/4 the time **when the knowledge & skills are needed***
- ◆ We can initiate and foster this revolution by:
 - *Emphasize collaborative asynchronous distributed learning (Just-in-time & unit based)*
 - *Develop/apply (military & civilian) standards (being done by OSD P&R)*
 - *Modernize & automate courseware development and courseware upgrading*
 - *Institute a program of learning research for DoD-specific training*

Impediments to Training Changes

◆ We found a *perceived* Training Resource Syllogism

Major Premise: We can't pay for everything

Minor Premise: Training time-constants are much shorter than acquisition ones

Therefore: **Buy hardware now.**

Fix training later.

✧ Unfortunately, *training systems* can not be created in short order; there is no COTS source for military force/unit training

✧ This kind of misguided reasoning will prevail as long as there are no effective measuring sticks for training or proficiency

◆ Most* training R&D today is ad hoc, local, and small scale

➤ *There is no research to bind together the elements of the new revolution*

✧ The training labs have been dispersed, disestablished, or down-sized

➤ *Schoolhouses currently resist major shifts to distributed learning*

◆ Different “colors of money” impede training improvements

➤ *Start-up costs can't be derived from future savings in different accounts*

* Major exception is OSD P&R setting of nationwide distributed learning standards

Impediments to Training Changes (continued)

◆ Training management and resources are diffuse

- ✧ Personnel policies/management are handled by different folks than training policies/management for the same individuals but the unit commander only cares that the forces are trained.
- ✧ One set of people are concerned with technical training
- ✧ Unit training is the responsibility of yet different folks
- ✧ Logistics training resides elsewhere
- ✧ Joint training is the responsibility of ...
- ✧ Dollar resources are as diffuse as management responsibilities
- ✧ Tradeoffs among stovepipes are difficult below Service Chief level

◆ Therefore we are faced with a complex structural problem:

- *How can we use savings from training efficiencies of the training revolution & improved personnel management to fund more & improved unit/joint training?*

◆ There is no “Military-Training Complex” to lobby for training systems

Man, Equip and Train

- ◆ Man and Equip are measured; *Training outputs are not*
 - *If you don't measure something, even the well-intentioned can ignore it*
 - ✧ NTC OPFOR Commander: "We don't measure our combat readiness in terms of our ability to accomplish our mission-essential tactics ... We measure it in terms of the number of leaders and soldiers we have, the amount of equipment we have, the maintenance posture of equipment and available training resources."
 - ✧ Army Combined Arms Center developed data-collection plan for NTC performance in 1995. Cost \$2M/year. It was not funded.
 - ✧ Training Performance Data Center, established as result of 1982 DSB report, was eliminated in early 1990s due to lack of high-level support
 - ✧ If you only measure inputs (training loads), not outputs (effectiveness of trained individuals), there is no good basis for making tradeoffs
 - *This task force was unable even to get an accounting from the Services for the money they allot to individual, unit and force level training*
- ◆ There is no *effective* voice in the Pentagon who is graded on overall training performance
 - *Not in Personnel & Readiness, in Acquisition, in Services, or in Joint Forces*
 - *All major training achievements that we saw were the result of a few extraordinary individuals exercising their existing authority. We should not wait for another one to appear spontaneously.*

Red Training & Training Surprise

- ◆ CTC training culture can be learned
 - *E.g., U.S.-trained Kuwaiti pilots benefit from Red Flag; French-trained can't*
- ◆ *Initial* Intelligence Community (IC) perspective:
 - *Potential adversaries are destitute and cannot afford good training*
 - *DSB saw no initial evidence that IC would detect training breakthroughs*
- ◆ NIO (Conventional Military Issues) convened the **first ever** assembly of senior intel analysts to examine training surprise
 - ✧ They corroborated the 'rest of the world is destitute' assessment
 - ✧ Potential adversaries are not embracing CTC approach
 - ✧ They identified a third example of training surprise: Croatia in 1994
 - ◆ (first example is Top Gun/Viet Nam; second is NTC/Desert Storm)
 - ✧ Their collective answer was: an NTC-like center would be noticed
 - ✧ Not clear to us that they would see signs of the second training revolution
 - ✧ Export licenses for training technology and systems are easy to obtain
- ◆ The DoD should request a training breakthrough conclave yearly

Recommendations (1)

- ◆ **Services restore Air & Ground CTC Infrastructure**
 - ✧ Upgrade opposing forces to meet new kinds of threats
 - ✧ Consider commercial supplier for joint air aggressor (red) force
- ◆ **Services & JFCOM report to DEPSECDEF how to *apply CTC paradigm to additional forces and new/joint warfare areas***
- ◆ **DEPSECDEF task Services and CINCs (for joint training) to *deliver yearly training assessment scorecard***
 - ✧ Covering training status both for deployed forces & in systems acquisition
 - ✧ Endorsed by CINCs and, where appropriate, by a CTC OPFOR CDR
 - ✧ Service-chosen format, but to include: performance metrics & spending
- ◆ **DEPSECDEF & CJCS request similar *yearly report on foreign training* from Intelligence Community re: training surprise**
- ◆ **For *each new acquisition*, define a *Training Subsystem* co-equal with other subsystems & funded with acquisition \$**
 - ✧ USD(AT&L), DEPSECDEF task DoD & Service OT&E to demonstrate Training Subsystem in final OT&E by training and testing a 'randomly' selected unit
- ◆ **USD(P&R) provide oversight on DAB for training issues**

Recommendations (2)

◆ USDs (P&R) & (AT&L) foster the second training revolution:

➤ *Provide quantitative evaluation:*

✧ USD P&R, AT&L **recommend resource reallocations** to DEPSECDEF within pers & training functions to achieve best trained force/units for DoD missions

➤ *Support a goal to **move 50% of schoolhouse training to unit-based training in 5 years.** To initiate this change:*

✧ USD(P&R) fund **pilot program** in each Service to convert major training courses from classroom-based to **self-paced learning** by FY02

✧ USD(P&R) fund 2nd **pilot program** in each Service to move major training programs from residential to **unit-based instruction** by FY02

✧ Services nominate courses. P&R fund & develop **performance measurements**

➤ *USDs (P&R)&(AT&L) **establish (6.3) PE for training** technology research*

➤ ***DARPA create a new office** and research program to develop high payoff training and human performance technologies*

➤ *Services institute ACTD-like **pilot programs** in recruiting & course development **using multiple kinds of intelligence** to predict performance*

◆ SECDEF **designate ASD or DUSD** (existing or new) to be graded on Service & joint training *performance*. Services do the same.

Summary

- ◆ Our uniquely American *Training Superiority* is eroding
- ◆ JV2010/2020 future will require more training, not less
- ◆ Training failure will negate hardware promise
- ◆ A second revolution in training is needed and is possible
 - *This new revolution should be able to pay for itself but:*
 - ✧ The incentive structure in the DoD won't foster the revolution without help
 - ◆ A central cause is that *training performance is not measured*
- ◆ Training should take its Title 10 seat with “Man & Equip”
 - *Restore & expand upon crown jewels of current training revolution (CTCs)*
 - *Establish and test co-equal training subsystem in each acquisition program*
 - *Raise OSD/Acquisition training conscience:*
 - ✧ Services & CINCs deliver annual training report card to Deputy Sec. Defense
 - ✧ Designate ASD/DUSD to be held accountable for training performance
 - *Foster the second training revolution by establishing:*
 - ✧ ACTD-like pilot programs in computerized self-paced and unit-based training
 - ✧ An advanced training research program element
 - ✧ DARPA office to develop high payoff training/human performance technology
- ◆ DoD & Intel Community act to detect & avoid Training Surprise

Last Words

Training counts

Warfighting success is as dependent upon the proficiency of people as it is upon the hardware with which they fight.

We need training superiority as much as we need technical superiority.

We don't count training

We measure process, not proficiency,
and what you don't measure or report, you can ignore.

Without structural changes in the DoD, training won't take its place at the table with *man & equip*

Unless it does, we will negate much of the promise of the Joint Vision warfare transformation.

If it does, we will be able to maintain and expand our training superiority without significant additional cost.

More Last Words

- ◆ New Task Force working since this spring:
Training for Future Conflicts
- ◆ Services and JCS claim that they will transform warfare.
- ◆ Who is going to transform the warriors?
 - *If training is to supply people who can fight under the new paradigms:*
 - ✧ It cannot be done in the old way, based upon the existing training system.
 - ✧ It must not be developed as an afterthought
- ◆ Nothing short of a revolution in training will do.
 - ✧ The Army, in spoken words accompanying a viewgraph, said that a training revolution is needed if the FCS is to succeed, but they don't know how.
 - ✧ We have seen nobody else who even recognizes the need.
- ◆ Part of a larger issue:
 - *Can this be done at all?*
 - *Who is in charge of doing it?*